U.S. DEPARTMENT OF COMMERCE
National Technical Information Service
PB-276 911

Ocean Lake
Fremont County, Wyoming

National Eutrophication Survey, Corvallis, Oreg

Prepared for

Corvallis Environmental Research Lab, Oreg

Aug 77

PB 276 911

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

☆G.P.O. 699-440

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

PB278911

1. REPORT NO.	2.
3. RECIPIENT'S ACCESSION NO.	
4. TITLE AND SUBTITLE Report on Ocean Lake, Fremont County, Wyoming	5. REPORT DATE Prepared August 1977
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)	8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 889
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330	10. PROGRAM ELEMENT NO.
	11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460	13. TYPE OF REPORT AND PERIOD COVERED Final - 1975
	14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		48G

18. DISTRIBUTION STATEMENT Release unlimited	19. SECURITY CLASS (This Report)	21. NO. OF PAGES 43
	20. SECURITY CLASS (This page)	22. PRICE A03 - A01

EPA Form 2220-1 (9-73)

REPORT

ON

OCEAN LAKE

FREMONT COUNTY

WYOMING

EPA REGION VIII

WORKING PAPER No. 889

WITH THE COOPERATION OF THE

WYOMING DEPARTMENT OF ENVIRONMENTAL QUALITY

AND THE

WYOMING NATIONAL GUARD

AUGUST, 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Wyoming Department of Environmental Quality for professional involvement, to the Wyoming National Guard for conducting the tributary sampling phase of the Survey, and to those Wyoming wastewater treatment plant operators who voluntarily provided effluent samples.

The staff of the Water Quality Division provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

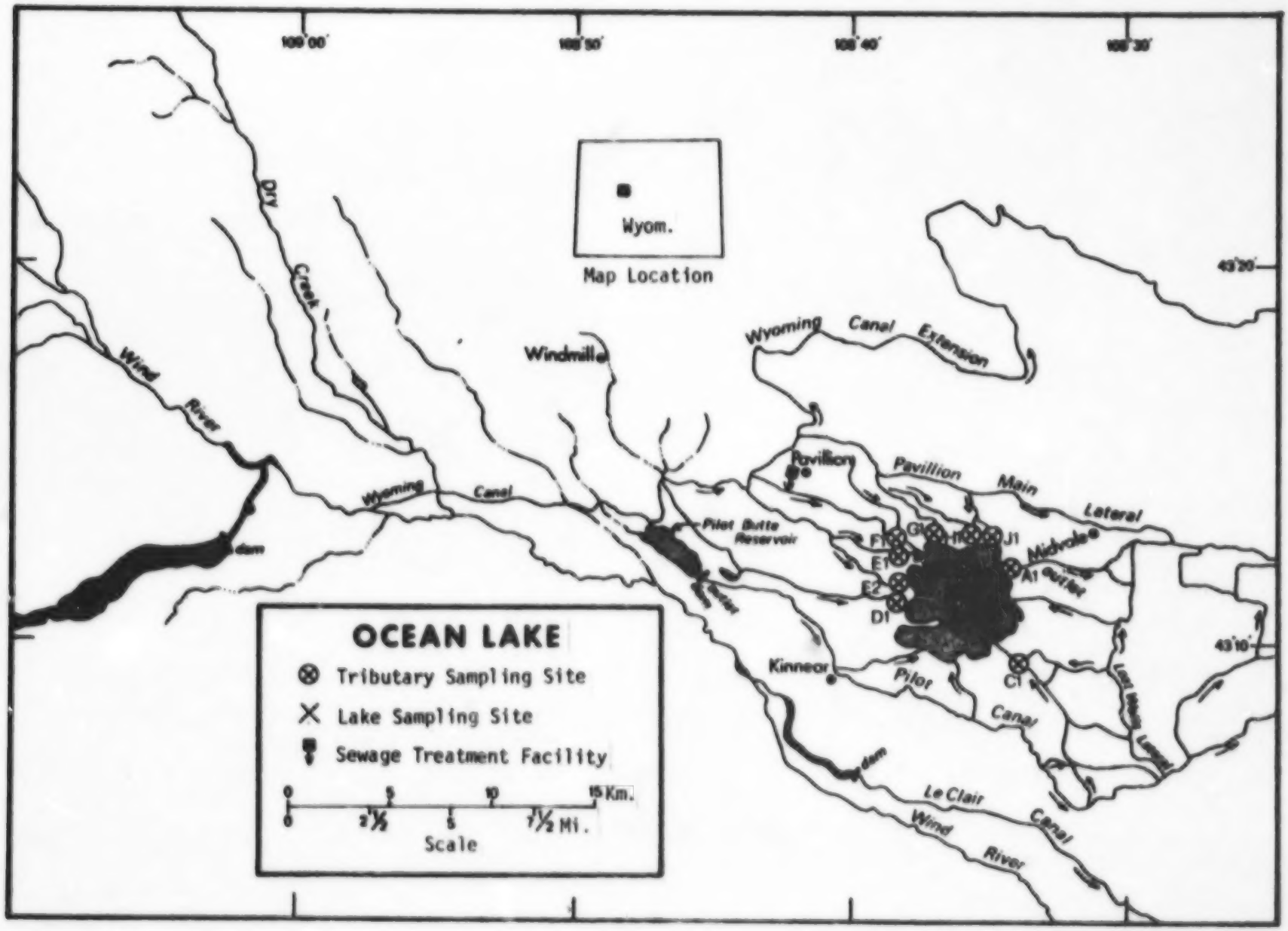
Brigadier General James L. Spence, The Adjutant General of Wyoming, and Project Officer Colonel Donald L. Boyer, who directed the volunteer efforts of the Wyoming National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of Wyoming

NAME	COUNTY
Big Sandy	Sublette, Sweetwater
Boulder	Sublette
Boysen	Fremont
De Smet	Johnson
Flaming Gorge	Sweetwater, WY; Daggett, UT
Fremont	Sublette
Glendo	Converse, Platte
Keyhole	Crook
Ocean	Fremont
Seminoe	Carbon
Soda	Sublette
Viva Naughton	Lincoln
Woodruff Narrows	Uinta
Yellowtail	Bighorn, WY; Bighorn, Carbon, MT



OCEAN LAKE
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
0 5 10 15 Km.
0 2½ 5 7½ Mi.
Scale
Wyom.
Map Location
109°00'
108°50'
108°40'
108°30'
43°20'
43°10'
Dry Creek
Wind River
Wyoming Canal
Windmill
Wyoming Canal Extension
Pavillion
Pavillion Main Lateral
Midvale
Pilot Butte Reservoir
Kinneor
Pilot Canal
Le Clair Canal
Wind River
dam
F1
G1
H1
J1
E1
E2
D1
A1
C1

OCEAN LAKE

STORET NO. 5609

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Ocean Lake is eutrophic. It ranked fifth in overall trophic quality when the 14 Wyoming lakes and reservoirs sampled in 1975 were compared using a combination of six water quality parameters*. Eight of the water bodies had less median total phosphorus, three had less and one had the same median dissolved orthophosphorus, none had less but four had the same median inorganic nitrogen, eight had less mean chlorophyll a, and 12 had greater mean Secchi disc transparency.

Survey limnologists noted that the lake had a milky green appearance during the September sampling, and the chlorophyll a concentration and numbers of phytoplankton in October indicate a light bloom (see page 6). In a previous report it is suggested that eutrophication of this waterbody probably is responsible for changes in the abundance of certain species of fish (Anonymous, 1974).

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of conditions in the lake at the times the samples were taken

* See Appendix A.

(05/19/75 and 10/16/75) due to significant changes in nutrient levels during sample shipment from the field to the laboratory.

The lake data indicate nitrogen limitation in May and October and phosphorus limitation in September.

C. Nutrient Controllability:

1. Point sources--The only known point source, the Pavillion wastewater treatment plant, contributed 1.1% of the total phosphorus input to Ocean Lake during the sampling year.

The present phosphorus loading of 0.26 g/m^2/year is more than that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading. However, since the point-source load is relatively small, any improvement in the present trophic condition is dependent on control of non-point sources.

2. Non-point sources--Non-point sources accounted for 98.9% of the total phosphorus load during the sampling year. Pilot Drain contributed 55.7%, Unnamed Creek F-1 contributed 26.5%, Unnamed Creek H-1 contributed 2.1%, and the Sand Butte Aqueduct (stations E-1 and E-2, collectively) contributed 6.0%. The ungaged minor tributaries and immediate drainage contributed an estimated 2.0% of the total.

Areas surrounding the lake are used extensively for farming. As a consequence, nutrient loads in irrigation return flows and natural runoff probably are the most significant contributors to the enrichment of the lake. A further study is needed to determine the controllability of nutrients from such sources.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 24.68 kilometers^2.
2. Mean depth: 4.2 meters.
3. Maximum depth: 7.9 meters.
4. Volume: 103.656 x 10^6 m^3.
5. Mean hydraulic retention time: 4.4 years (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Pilot Drain	-	0.550
Sand Butte Aqueduct E-1	-	0.059
Sand Butte Aqueduct E-2	-	0.033
Unnamed Creek F-1	-	0.480
Unnamed Creek H-1	-	0.050
Minor tributaries & immediate drainage -	-	0.033
Total	-	1.205

2. Outlet -

Ocean Drain	-	0.750

C. Precipitation**:

1. Year of sampling: 23.3 centimeters.
2. Mean annual: 21.7 centimeters.

† Table of metric equivalents--Appendix B.
†† Prior, 1974.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976"; no drainage areas (flow is regulated).
** See Working Paper No. 175.

III. WATER QUALITY SUMMARY

Ocean Lake was sampled three times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at one station on the lake (see map, page v). During each visit, a single depth integrated (4.6 m to surface) sample was collected for phytoplankton identification and enumeration and a similar sample was collected for chlorophyll a analysis. During the first and last visits, a single 18.9-liter depth-integrated sample was taken for algal assays. The maximum depth sampled was 6.4 meters.

The sampling results are presented in full in Appendix D and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR OCEAN LAKE
STORET CODE 5609

PARAMETER	1ST SAMPLING (5/19/75) 1 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (9/ 2/75) 1 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (10/16/75) 1 SITES RANGE	MEAN	MEDIAN
TEMP (C)	12.7 - 12.7	12.7	12.7	18.6 - 18.8	18.7	18.7	12.7 - 12.8	12.8	12.8
DISS OXY (MG/L)	7.8 - 10.0	8.4	8.0	6.4 - 7.0	6.7	6.8	8.4 - 8.8	8.7	8.8
CNDCTVY (MCHOMO)	1416. - 1417.	1417.	1417.	1379. - 1426.	1396.	1384.	1119. - 1121.	1120.	1121.
PH (STAND UNITS)	8.2 - 8.4	8.3	8.4	8.2 - 8.4	8.3	8.4	8.4 - 8.5	8.5	8.5
TOT ALK (MG/L)	296. - 310.	305.	307.	195. - 196.	196.	196.	198. - 200.	199.	199.
TOT P (MG/L)	0.039 - 0.045	0.041	0.041	0.038 - 0.048	0.042	0.040	0.046 - 0.053	0.048	0.046
ORTHO P (MG/L)	0.015 - 0.017	0.016	0.016	0.003 - 0.003	0.003	0.003	0.003 - 0.005	0.004	0.003
NO2+NO3 (MG/L)	0.020 - 0.020	0.020	0.020	0.020 - 0.020	0.020	0.020	0.020 - 0.020	0.020	0.020
AMMONIA (MG/L)	0.020 - 0.020	0.020	0.020	0.020 - 0.030	0.023	0.020	0.020 - 0.020	0.020	0.020
KJEL N (MG/L)	0.800 - 1.000	0.900	0.900	0.800 - 0.800	0.800	0.800	0.700 - 0.800	0.767	0.800
INORG N (MG/L)	0.040 - 0.040	0.040	0.040	0.040 - 0.050	0.043	0.040	0.040 - 0.040	0.040	0.040
TOTAL N (MG/L)	0.820 - 1.020	0.920	0.920	0.820 - 0.820	0.820	0.820	0.720 - 0.820	0.787	0.820
CHLRPYL A (UG/L)	5.0 - 5.0	5.0	5.0	5.4 - 5.4	5.4	5.4	12.1 - 12.1	12.1	12.1
SECCHI (METERS)	0.7 - 0.7	0.7	0.7	0.4 - 0.4	0.4	0.4	0.6 - 0.6	0.6	0.6

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
05/19/75	1. *Cryptomonas sp.*	981
	2. *Tabellaria sp.*	235
	3. *Nitzschia sp.*	157
	4. *Schroederia sp.*	118
	5. *Chlorogonium sp.*	78
	Other genera	196
	Total	1,765
09/02/75	1. *Oocystis sp.*	609
	2. *Cryptomonas sp.*	578
	3. *Aphanizomenon sp.*	183
	4. *Scenedesmus sp.*	91
	5. *Anabaena sp.*	30
	Other genera	61
	Total	1,552
10/16/75	1. Chlorophytan filaments	1,891
	2. *Asterionella sp.*	1,833
	3. *Cryptomonas sp.*	1,251
	4. *Chroomonas (?) sp.*	1,222
	5. *Ankistrodesmus sp.*	291
	Other genera	290
	Total	6,778

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (μg/l)
05/19/75	1	5.0
09/02/75	1	5.4
10/16/75	1	12.1

C. Limiting Nutrient Study:

Due to significant changes in nutrient levels in the samples during shipment from the field to the laboratory, the algal assay results are not considered representative of conditions in the lake at the time the samples were collected (05/19/75 and 10/16/75).

The lake data indicate nitrogen limitation in May and October and phosphorus limitation in September; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 3/1 and 10/1 in May and October, respectively, and 14/1 in September.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Wyoming National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v), except for the high runoff month of June when two samples were collected at six of the sites. Sampling was begun in October, 1974, and was completed in August, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Wyoming District Office of the U.S. Geological Survey for the tributary sites near the lake.

In this report, nutrient loads for sampled tributaries were calculated using mean annual concentrations and mean annual flows. Nutrient loads shown are those measured minus point-source loads, if any.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean concentrations in Sand Butte Aqueduct at stations E-1 and E-2 and the mean annual ZZ flow.

The operator of the Pavillion wastewater treatment plant provided monthly effluent samples and corresponding flow data.

A. Waste Sources:

1. Known municipal* -

Name	Pop. Served	Treatment	Mean Flow (m^3/d)	Receiving Water
Pavillion	180	stab. pond	52.4	Drainage Ditch/ Ocean Lake

* Pinther, 1976.

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Pilot Drain	3,640	55.7
Sand Butte Aqueduct E-1	345	5.3
Sand Butte Aqueduct E-2	50	0.7
Unnamed Creek F-1	1,730	26.5
Unnamed Creek H-1	140	2.1
b. Minor tributaries & immediate drainage (non-point load) -	130	2.0
c. Known municipal STP's -		
Pavillion	70	1.1
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	430	6.6
Total	6,535	100.0

2. Outputs -

Lake outlet - Ocean Drain 710

3. Net annual P accumulation - 5,825 kg.

* See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/ yr	% of total
a. Tributaries (non-point load) -		
Pilot Drain	34,670	37.6
Sand Butte Aqueduct E-1	2,385	2.6
Sand Butte Aqueduct E-2	430	0.4
Unnamed Creek F-1	24,265	26.3
Unnamed Creek H-1	2,725	3.0
b. Minor tributaries & immediate drainage (non-point load) -	930	1.0
c. Known municipal STP's -		
Pavillion	225	0.2
d. Septic tanks - None	-	-
e. Known industrial - None	-	-
f. Direct precipitation* -	26,645	28.9
Total	92,275	100.0

2. Outputs -

Lake outlet - Ocean Drain 34,435

3. Net annual N accumulation - 57,840 kg.

* See Working Paper No. 175.

D. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	0.26	0.24	3.7	2.3

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Ocean Lake:	
"Dangerous" (eutrophic loading)	0.20
"Permissible" (oligotrophic loading)	0.10

V. LITERATURE REVIEWED

Anonymous, 1974. Annual progress report. WY Game & Fish Comm., Cheyenne.

Pinther, Robert, 1976. Personal communication (Pavillion STP). WY Dept. of Env. Qual., Cheyenne.

Prior, 1974. Personal communication (lake morphometry). Dept. of Env. Qual., Cheyenne.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
5601	BIG SANDY RESERVOIR	0.087	0.060	487.667	4.383	8.800	0.020
5602	BOULDER LAKE	0.008	0.040	361.800	2.483	8.400	0.002
5603	BOYSEN RESERVOIR	0.037	0.140	465.923	6.264	14.400	0.014
5604	LAKE DE SHET	0.033	0.040	409.000	11.167	9.400	0.006
5605	FLAMING GORGE RESERVOIR	0.014	0.605	366.461	5.611	12.200	0.003
5606	FREMONT LAKE	0.006	0.040	-22.000	3.783	7.400	0.002
5607	GLENDO RESERVOIR	0.045	0.315	459.182	8.473	12.600	0.014
5608	KEY HOLE RESERVOIR	0.028	0.050	454.583	7.792	14.000	0.004
5609	OCEAN LAKE	0.043	0.040	478.333	7.500	8.600	0.004
5610	SEMINOLE RESERVOIR	0.030	0.130	447.000	2.536	11.000	0.007
5611	SODA LAKE	0.063	0.040	387.500	5.575	15.000	0.014
5612	VIVA NAUGHTON RESERVOIR	0.065	0.120	430.000	25.067	13.200	0.024
5613	WOODRUFF NARROWS RESERVO	0.069	0.105	470.000	12.950	13.200	0.019
5614	YELLOWTAIL RESERVOIR	0.026	0.310	364.500	5.410	10.000	0.017

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
5601	BIG SANDY RESERVOIR	0 (0)	54 (7)	0 (0)	77 (10)	77 (10)	8 (1)	216
5602	BOULDER LAKE	92 (12)	92 (11)	92 (12)	100 (13)	92 (12)	92 (12)	560
5603	HOYSEN RESERVOIR	46 (6)	23 (3)	23 (3)	46 (6)	8 (1)	42 (5)	188
5604	LAKE DE SHET	54 (7)	73 (9)	62 (8)	15 (2)	69 (9)	62 (8)	335
5605	FLAMING GORGE RESERVOIR	85 (11)	0 (0)	77 (10)	54 (7)	46 (6)	85 (11)	347
5606	FREMONT LAKE	100 (13)	73 (9)	100 (13)	85 (11)	100 (13)	100 (13)	558
5607	GLENDO RESERVOIR	31 (4)	8 (1)	31 (4)	23 (3)	38 (5)	42 (5)	173
5608	KEY HOLE RESERVOIR	69 (9)	62 (8)	38 (5)	31 (4)	15 (2)	69 (9)	284
5609	OCEAN LAKE	38 (5)	92 (11)	8 (1)	38 (5)	85 (11)	77 (10)	338
5610	SEMINOLE RESERVOIR	62 (8)	31 (4)	46 (6)	92 (12)	54 (7)	54 (7)	339
5611	SODA LAKE	23 (3)	92 (11)	69 (9)	62 (8)	0 (0)	31 (4)	277
5612	VIVA NAUGHTON RESERVOIR	15 (2)	38 (5)	54 (7)	0 (0)	27 (3)	0 (0)	134
5613	WOODRUFF NARROWS RESERVO	8 (1)	46 (6)	15 (2)	8 (1)	27 (3)	15 (2)	119
5614	YELLOWTAIL RESERVOIR	77 (10)	15 (2)	85 (11)	69 (9)	62 (8)	23 (3)	331

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	5602	BOULDER LAKE	560
2	5606	FREMONT LAKE	558
3	5605	FLAMING GORGE RESERVOIR	347
4	5610	SEMINOLE RESERVOIR	339
5	5609	OCEAN LAKE	338
6	5604	LAKE DE SMET	335
7	5614	YELLOWTAIL RESERVOIR	331
8	5608	KEY HOLE RESERVOIR	284
9	5611	SODA LAKE	277
10	5601	BIG SANDY RESERVOIR	216
11	5603	BOYSEN RESERVOIR	188
12	5607	GLENDO RESERVOIR	173
13	5612	VIVA NAUGHTON RESERVOIR	134
14	5613	WOODRUFF NARROWS RESERVO	119

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR WYOMING 08/05/76

LAKE CODE 5609 OCEAN LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 0.0

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
5609A1	0.0	0.37	0.45	0.48	0.57	0.54	0.85	1.25	1.30	1.42	0.71	0.57	0.51	0.75
5609D1	0.0	0.17	0.17	0.20	0.23	0.23	0.42	1.13	1.98	1.42	0.17	0.17	0.23	0.55
5609E1	0.0	0.0	0.0	0.0	0.0	0.113	0.142	0.142	0.170	0.142	0.0	0.0	0.0	0.059
5609E2	0.0	0.0	0.0	0.0	0.0	0.028	0.085	0.085	0.113	0.085	0.0	0.0	0.0	0.033
5609F1	0.0	0.11	0.11	0.11	0.11	0.17	0.85	1.42	1.70	0.57	0.20	0.20	0.14	0.48
5609H1	0.0	0.0	0.028	0.028	0.028	0.057	0.113	0.113	0.113	0.057	0.028	0.028	0.0	0.050
5609Z2	0.0	0.028	0.028	0.028	0.028	0.057	0.057	0.028	0.028	0.028	0.028	0.028	0.028	0.033

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 0.0 TOTAL FLOW IN = 0.40
SUM OF SUB-DRAINAGE AREAS = 0.0 TOTAL FLOW OUT = 22.91

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5609A1	10	74	1.982	5	2.265				
	11	74	1.557	2	1.699				
	12	74	0.991	7	1.133	29	0.850		
	1	75	0.708						
	2	75	0.708	1	0.708				
	3	75	0.708	1	0.708				
	4	75	0.708	14	0.708				
	5	75	0.566	3	0.566	17	0.425		
	6	75	1.133	30	1.699				
	7	75	1.982	27	2.407				
	8	75	2.832	24	3.115				
	9	75	1.982						
5609D1	10	74	0.170	5	0.170				
	11	74	0.170	2	0.170				
	12	74	0.227	7	0.283				
	1	75	0.170						
	2	75	0.170						
	3	75	0.198	1	0.198				
	4	75	0.227	2	0.227	14	0.227		
	5	75	0.227	17	0.227				
	6	75	0.425	7	0.227	30	0.595		
	7	75	1.982	27	3.398				
	8	75	4.248	24	4.814				
	9	75	1.982						

NO

TRIBUTARY FLOW INFORMATION FOR WYOMING 06/05/76

LAKE CODE 5609 OCEAN LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
5609E1	10	74	0.0						
	11	74	0.0						
	12	74	0.0						
	1	75	0.0						
	2	75	0.0						
	3	75	0.0						
	4	75	0.0						
	5	75	0.085	17	0.142				
	6	75	0.142	7	0.142	30	0.142		
	7	75	0.142	27	0.142				
	8	75	0.170	24	0.170				
	9	75	0.142						
5609E2	10	74	0.0						
	11	74	0.0						
	12	74	0.0						
	1	75	0.0						
	2	75	0.0						
	3	75	0.0						
	4	75	0.0						
	5	75	0.028						
	6	75	0.085	30	0.085				
	7	75	0.085	27	0.085				
	8	75	0.113	24	0.113				
	9	75	0.085						
5609F1	10	74	0.198	5	0.198				
	11	74	0.198	2	0.198				
	12	74	0.142	7	0.142	29	0.113		
	1	75	0.113						
	2	75	0.113	1	0.113				
	3	75	0.113	1	0.113				
	4	75	0.113	14	0.113				
	5	75	0.170	3	0.113	17	0.227		
	6	75	0.850	7	0.566	30	0.991		
	7	75	1.416	27	1.699				
	8	75	1.699	24	1.699				
	9	75	0.566						
5609H1	10	74	0.028	5	0.028				
	11	74	0.028	2	0.028				
	12	74	0.028	7	0.028				
	1	75	0.0						
	2	75	0.028						
	3	75	0.028						

21

TRIBUTARY FLOW INFORMATION FOR WYOMING 08/05/76

LAKE CODE 5609 OCEAN LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
560922	10	74	0.028						
	11	74	0.028						
	12	74	0.028						
	1	75	0.028						
	2	75	0.028						
	3	75	0.028						
	4	75	0.028						
	5	75	0.057						
	6	75	0.057						
	7	75	0.028						
	8	75	0.028						
	9	75	0.028						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/08/05

560901
43 11 26.0 108 36 41.0 3
OCEAN LAKE
56013 WYOMING

890291

11EPALES 2111202
0025 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/05/19	11 25	0000	12.7	10.0	26	1417	8.20	296	0.020	1.000	0.020K	0.017
	11 25	0005	12.7	7.8		1417	8.40	310	0.020	0.900	0.020K	0.015
	11 25	0015	12.7	8.0		1416	8.40	306	0.020	0.800	0.020K	0.017
	11 25	0021	12.7	8.0		1416	8.40	308	0.020	0.900	0.020K	0.016
75/09/02	12 35	0000	18.8	6.8	15	1426	8.20	196	0.030	0.800	0.020K	0.003
	12 35	0005	18.7	6.4		1384	8.40	196	0.020	0.800	0.020K	0.003
	12 35	0018	18.6	7.0		1379	8.40	195	0.020	0.800	0.020K	0.003
75/10/16	09 15	0000	12.7	8.4	24	1121	8.40	198	0.020K	0.700	0.020K	0.003
	09 15	0005	12.8	8.8		1121	8.50	199	0.020K	0.800	0.020K	0.005
	09 15	0018	12.8	8.8		1119	8.50	200	0.020K	0.800	0.020K	0.003

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/05/19	11 25	0000	0.039	5.0	
	11 25	0005	0.042		
	11 25	0015	0.040		
	11 25	0021	0.045		
75/09/02	12 35	0000	0.038	5.4	
	12 35	0005	0.040		
	12 35	0018	0.048		
75/10/16	09 15	0000	0.046	12.1	
	09 15	0005	0.053		
	09 15	0018	0.046		

K VALUE KNOWN TO BE
LESS THAN INDICATED

24

APPENDIX E

TRIBUTARY AND WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 76/08/05

560941
43 11 57.0 108 34 36.0 4
OCEAN DRAIN
56 7.5 OCEAN LAKE
O/OCEAN LAKE 090291
DIRT RD BRDG 4 MI WSW OF MIDVALE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	11 40		0.032	1.000	0.050	0.010	0.040
74/11/02	10 55		0.040	3.350	0.065	0.010	0.050
74/12/07	10 30		0.016	0.800	0.016	0.005	0.030
74/12/29	11 06		0.024	1.750	0.024	0.005	0.030
75/02/01	10 15		0.006	1.600	0.030	0.009	0.020
75/03/01	10 00		0.005	0.750	0.015	0.005K	0.020
75/04/14	17 20		0.005	1.050	0.070	0.005K	0.020
75/05/03	11 20		0.012	1.200	0.028	0.024	0.030
75/05/17	15 22		0.010	0.700	0.025	0.006	0.030
75/06/30	18 05		0.010	0.700	0.020	0.005	0.030
75/07/27	16 55		0.010	3.000	1.050	0.005K	0.030
75/08/24	11 30		0.005	1.400	0.150	0.015	

K VALUE KNOWN TO BE
LESS THAN INDICATED

STORET RETRIEVAL DATE 76/06/05

560901
43 09 30.0 108 33 52.0 4
UNNAMED CANAL
56 7.5 OCEAN LAKE
T/OCEAN LAKE 090291
BRDG ON MAIN RD 6 MI SW OF MIDVALE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	12	26	0.400	0.700	0.030	0.020	0.040
74/11/07	11	30	0.432	2.000	0.130	0.010	0.060
74/12/07	11	05	1.350	1.200	0.015	0.010	0.020
74/12/29	11	30	2.080	1.700	0.054	0.015	0.030
75/03/01	10	22	1.050	1.800	0.130	0.130	0.220
75/04/14	17	55	0.105	1.600	0.030	0.030	0.170
75/05/03	11	50	0.075	0.850	0.020	0.020	0.260
75/05/17	15	45	0.035	0.650	0.025	0.015	0.170
75/06/07	15	30	0.315	1.650	0.255	0.148	0.200
75/06/30	19	00	0.055	0.700	0.020	0.060	0.180
75/07/27	17	20	0.110	1.300	0.220	0.120	0.270
75/08/24	11	50	0.040	0.500	0.015	0.045	0.130

STORET RETRIEVAL DATE 76/08/05

560901
43 11 10.0 108 36 15.0 4
PILOT DRAIN
56 7.5 PAVILLION
T/OCEAN LAKE 090291
0MOD 7 MI SE OF PAVILLION
IIEPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	09 50		0.910	1.250	0.030	0.005	0.065
74/11/02	09 50		1.160	1.200	0.040	0.005	0.100
74/12/07	09 37		1.460	0.700	0.030	0.005	0.080
74/12/29	10 30		1.680	1.100	0.040	0.015	0.130
75/03/01	09 00		1.000	1.550	0.170	0.025	0.310
75/04/02	10 00		0.730	1.700	0.035	0.070	0.040
75/04/14	16 45		0.700	2.500	0.040	0.010	0.075
75/05/17	17 20		0.345	0.750	0.035	0.010	0.110
75/06/07	17 35		1.720	1.100	0.095	0.670	0.835
75/06/30	15 00		0.260	0.800	0.025	0.060	0.240
75/07/27	15 30		0.190	0.800	0.085	0.090	0.380
75/08/24	10 35		0.185	0.660	0.030	0.030	0.160

STORET RETRIEVAL DATE 76/08/05

560961
43 12 30.0 108 38 15.0 4
SAND BUTTE AQUADUCT
56 7.5 PAVILLION
T/OCEAN LAKE 090291
BRDG ON PAVED RD 5.4 MI SE OF PAVILLION
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/05/17	14 35		0.025	0.700	0.015	0.040	0.220
75/06/07	18 50		2.100	1.750	0.110	0.135	0.440
75/06/30	17 20		0.025	0.450	0.045	0.040	0.120
75/07/27	15 30		0.010	0.550	0.050	0.030	0.100
75/08/24	10 55		0.005	0.800	0.010	0.015	0.050

STORET RETRIEVAL DATE 76/08/05

560VE2
43 11 27.0 108 38 15.0 4
SAND BUTTE AQUADUCT
56 7.5 PAVILLION
T/OCEAN LAKE 090291
PAVED RD BRDG 6.7 MI SE OF PAVILLION
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	10 35		0.016	0.630	0.035	0.010	0.030
75/06/30	17 10		0.015	0.542	0.020	0.065	0.100
75/07/27	15 40		0.005	0.350	0.020	0.030	0.050
75/08/24	10 45		0.005	0.100	0.005	0.010	0.010

STORET RETRIEVAL DATE 76/08/05

560903
43 12 40.0 108 36 15.0 4
UNNAMED CREEK
56 7.5 PAVILLION
T/OCEAN LAKE 090291
PAVED RD BRDG 5.3 MI SE OF PAVILLION
11EPALES 211120
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	10 45		0.640	0.700	0.070	0.042	0.042
74/11/02	10 20		0.660	0.800	0.027	0.010	0.060
74/12/07	10 00		1.020	0.600	0.035	0.005	0.040
74/12/29	10 45		1.200	1.100	0.092	0.035	0.060
75/02/01	09 40		1.350	1.300	0.112	0.032	0.080
75/03/01	09 30		0.810	0.950	0.115	0.060	0.150
75/04/14	17 00		0.400	1.600	0.035	0.010	0.050
75/05/03	10 25		0.590	0.500	0.019	0.022	0.022
75/05/17	14 50		0.210	1.600	0.030	0.055	0.385
75/06/07	15 05		1.300	0.350	0.020	0.075	0.080
75/06/30	17 25		0.315	1.000	0.070	0.090	0.230
75/07/27	16 05		0.145	1.350	0.155	0.055	0.230
75/08/24	11 00		0.150	0.400	0.010	0.050	0.120

STORET RETRIEVAL DATE 76/08/05

560961
43 12 52.0 108 37 04.0 4
CROOKED CREEK
56 7.5 OCEAN LAKE
T/OCEAN LAKE 090291
MISSOURI VALLEY RD BROG 5 M W OF MIDVALE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
75/06/07	14 55		2.200	0.350	0.025	0.045	0.100
75/06/30	17 30		0.045	1.300	0.035	0.065	0.170
75/07/27	16 15		0.010	0.400	0.020	0.040	0.100
75/08/24	11 05		0.005	1.300	0.020	0.015	0.060

STORET RETRIEVAL DATE 76/08/05

563941
43 12 52.0 109 35 32.0 4
UNNAMED CREEK
56 7.5 OCEAN LAKE
T/OCEAN LAKE 090291
MISSOURI VLY RD BRDG 3.75 M W OF MIDVALE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	11	20	0.880	0.500	0.025	0.020	0.040
74/11/02	10	35	1.060	1.200	0.045	0.015	0.060
74/12/07	10	15	1.630	1.000	0.055	0.010	0.020
75/04/14	17	15	0.490	2.600	0.065	0.015	0.050
75/05/03	10	45	0.740	0.800	0.030	0.030	0.050
75/05/17	15	03	0.320	1.700	0.045	0.015	0.040
75/06/07	14	12	1.050	0.150	0.015	0.015	0.015
75/06/30	17	30	0.060	1.000	0.035	0.185	0.270
75/07/27	16	25	0.045	1.130	0.040	0.085	0.170
75/08/24	11	10	0.135	0.800	0.020	0.123	0.180

STORET RETRIEVAL DATE 76/08/25

560901
+3 12 53.0 108 35 02.0 4
UNNAMED CREEK
56 7.5 OCEAN LAKE
T/OCEAN LAKE 090291
MISSOURI VALLEY RD BRDG 3.3 MI W MIDVALE
11EPALES 2111204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 N02&N03 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/10/05	11 25		0.064	0.400	0.020	0.015	0.030
75/06/07	13 55		1.050	0.700	0.035	0.035	0.035
75/06/30	17 45		0.020	0.700	0.020	0.060	0.100
75/07/27	16 35		0.010	1.400	0.090	0.150	0.300
75/08/24	11 15		0.005	0.500	0.030	0.025	0.190

STORET RETRIEVAL DATE 75/08/05

5603XA PO560 XA P000180
43 14 10.0 108 41 00.0 4
PAVILLION
56 7.5 PAVILLION
Ditch to Ocean Lake 090291

11EPALES 2141204
0000 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
75/02/10	12 30		0.080	21.100	5.400	4.700	4.800	0.013	0.015
75/03/04	12 30		0.080	15.000	5.400	4.700	5.200	0.010	0.012
75/04/14	11 30		0.100	17.500	0.630	4.600	5.800	0.012	0.012
75/04/30	12 00		0.100	15.000	0.210	4.700	4.700	0.009	0.010
75/05/19	11 00		0.150	14.500	0.530	5.200	5.900	0.009	0.010
75/06/09	10 00		0.100	6.500	1.050	3.700	4.100	0.012	0.013
75/07/01	10 00		0.100	5.800	0.066		1.400	0.012	0.011
75/07/21	15 00		0.025	4.100	0.025K	1.720	2.400	0.015	0.014
75/08/12	13 00		0.025	14.800	0.025K	1.600	3.400	0.015	0.016
75/09/08	10 00		0.075	9.200	0.025K	1.720	3.200	0.020	0.019
75/09/23	11 45		0.025	11.000	0.025K	1.150	2.400	0.016	0.016
75/10/14	14 30		0.100	9.700	0.610	1.700	2.700	0.016	0.016
75/11/11	17 00		0.050	14.000	0.100	2.900	3.700	0.012	0.015